Report of the Argo Science Team 3rd Meeting (AST-3)

March 20-22, 2001, Institute of Ocean Sciences, Sidney, B.C., Canada

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Summary

The third meeting of the Argo Science Team (AST-3) was held in Sidney, British Columbia, Canada from March 20-22, 2001. The substantial progress in international commitments over the past year was considered (Table 1). Committed floats now total over 900, with proposals for an average of 750 per year in the next 3 years. The geographic distribution of targeted floats was also addressed (Fig 1). Early Argo deployments seek to quickly demonstrate the value and success of the project, while leading to global implementation as the highest priority. Early deployments are very sparse in the southern subtropics and the Southern Ocean (Fig 1), so this must be a strong focus of subsequent efforts. Basin Implementation Meetings have been held for the Pacific Ocean (Tokyo, April 2000) and Atlantic Ocean (Paris, July 2000), with an Indian Ocean Implementation Meeting scheduled for Hyderabad, India in late July 2001.

Progress in development of the Argo Data System was reported, following a meeting of Argo data managers in Brest in October, 2000. A standing subcommittee of the AST was formed to oversee the Data System. Immediate issues for this group are: to ensure that all Argo data are being released in near real-time via the GTS, development of a common format to allow rapid exchange and dissemination of Argo data, and establishment of a timetable with milestones for implementation of the data system.

Technical issues relevant to the Argo array were reviewed. The most significant finding has been that of multi-year stable salinity records using Seabird CTDs, although there are not yet enough records of long duration to characterize the performance reliably. The most notable technical concern is for the viability of improved communications options that could provide fast, reliable two-way communications. While improvements are required for transmission of high quality data, the improved commercial systems presently lack financial stability. The AST decided to set up an online Argo technical forum will facilitate technical exchanges and information transfer among its members.

The Science Team focused on a number of issues related to international implementation.

- The Argo Information Centre (AIC). Float deployment notification procedures were discussed, including the necessity for float-providers to register new deployments on the AIC web site. The full-time Argo Coordinator will assist in a number of ways with Argo Implementation, with the first priority being establishment of an on-line float tracking system allowing anyone to determine the positions of floats presently deployed, as well as how the data from these floats can be accessed.
- Capacity building/SEREAD. It was stressed that Science Team members should participate in regional efforts aimed at building public awareness of Argo, support for Argo, and utilization of Argo data at several levels. An example was presented of an internationally supported secondary-school project in the Pacific Island nations that focuses on environmental science and Argo data - SEREAD.
- Regional action groups/EEZ issues. A discussion was held on regional cooperative efforts needed for Argo implementation, including the necessity to build broad international agreement and support for Argo float deployments within exclusive economic zones as well as on the high seas. An example was presented of successful regional action coordinated by the South Pacific Applied Geoscience Commission (SOPAC) to gain support for Argo implementation in the western Pacific.
- Float retrieval plan. The Science Team agreed that floats should be labeled in order to facilitate retrieval of those few instruments that may wash ashore or be recovered in fishing

activities, and will develop a consensus statement regarding associated safety and environmental issues.
- Members of the Science Team agreed to contribute materials for an internationally focused informational/ promotional CD.

Introduction

Argo is entering its implementation phase, with over 400 floats scheduled for deployment by late 2001 and sharply increasing numbers in the following years. Since the last Science Team meeting, implementation meetings have been held for the Pacific Ocean (Tokyo, April 2000) and Atlantic Ocean (Paris, July 2000), with an Indian Ocean implementation meeting scheduled for later this year. During this transition from planning to implementation, the Science Team will carefully track the progress of Argo in order to identify and solve short-term problems as well as to anticipate difficulties and opportunities that may be encountered in the coming years. The present meeting is intended to accomplish the following specific objectives:

- Review national plans, priorities and commitments. Are the individual float-providing nations meeting their goals? Will the total resources be sufficient for the global Argo array? (See section 2.1 of this report.)

- What is the international strategy for implementation in each ocean basin? Will this serve the purpose of quickly demonstrating the value of regional arrays for Argo users as well as leading efficiently to a global Argo array? (Section 2.2).

- What is the progress toward an internationally compatible and uniform data management structure? What elements of the data system are on line and what is the timetable for others? (Section 2.3)

- Review the technical issues relevant to Argo. Are the evolving technical capabilities of floats able to satisfy user requirements? What are the performance standards needed to ensure the value of the Argo array composed of intermingled floats from multiple float providers? (Section 3)

- Discuss international aspects of Argo and how the Science Team may participate in them to further contribute to Argo implementation and utilization of Argo data (Section 4).

2. Status of Argo planning and implementation

2.1. National Reports

The national reports presented in Appendix 1 constitute the Argo plans of the 13 float-providing nations plus a project funded by the European Commission. A tabulated summary of the funded and planned commitments to Argo, based on the national reports, is shown below. It indicates substantial progress over the past year, both in the numbers of floats to be deployed and in the number of participating countries. The increase in commitments is encouraging. If these plans are carried through there will be adequate floats for implementation of the global program. However, team members noted that much of the needed funding is still proposed rather than fully committed, and that most funding is for one-time projects. Therefore, full implementation and maintenance of the float array requires continuing attention. National projects must still be strongly promoted and should be conducted for a sustained period of time to demonstrate the high value and multiple applications of the float data. It is also noted that many of the committed floats have been funded outside of the Argo project, and although they will provide valuable Argo data, they cannot be specifically targeted to suit Argo priorities.

Number of Floats by Country	Argo Funded FY99	Float Equiv's FY99	Argo Funded FY00	Float Equiv's FY00	Argo Funded FY01	Float Equiv's FY01	Proposed over next 3 years	Prop Float Equiv's over 3 yrs
Australia			10		10		90	
Canada			10		42		90	
China					10		80	
Denmark						5		30
European Commission					80			
France		8	70		65		200	
Germany				18		22	100	35
India					6		150	
Japan			20		90		300	
New Zealand					2		10	
Republic of Korea					20		90	
Spain							24	
United Kingdom			13		50	5	150	40
U.S.A.	55		132	51	150	40	825	60
TOTALS	55	8	255	69	525	72	2109	165
TOTALS BY YEAR	FY99 = 63		FY00 = 324		FY01 = 597		Ave/Yr = 758	

Table 1: International Commitments for Argo floats. *This table reflects the year in which funds are provided for floats; it takes on the order of a year until such floats are available for deployment. To achieve the global array of 3,000 Argo floats, it is necessary to provide floats at a sustained rate of 750 per year, given an average float lifetime of 4 years.*

A "Float Equivalent" is defined as a float—while not funded under the Argo Program— whose data are available consistent with the Argo Data Policy and provides the information equivalent to one Argo float. Additional details on this table are provided in Appendix 2.

2.2. Basin implementation planning

The Argo implementation strategy places highest priority on attaining a full global network, rather than concentrating on regions or individual ocean basins, but with interim objectives of demonstrating the value and usefulness of Argo through regional arrays. An evaluation of the planned areas for float deployment in calendar years 2001 and 2002 (map below) shows strong efforts in the Atlantic Ocean and the western tropical Pacific plus substantial commitments in the tropical Indian Ocean. While this is completely appropriate for early demonstration of Argo success, it is noted that greater efforts in subsequent years are required in the southern hemisphere. For a complete Argo array, over 1200 floats are needed south of 30°S, with only a small fraction of that number planned for deployment through 2002. Future deployment strategies should stress globalization of the network and the high scientific value and exploratory nature of southern hemisphere sampling.

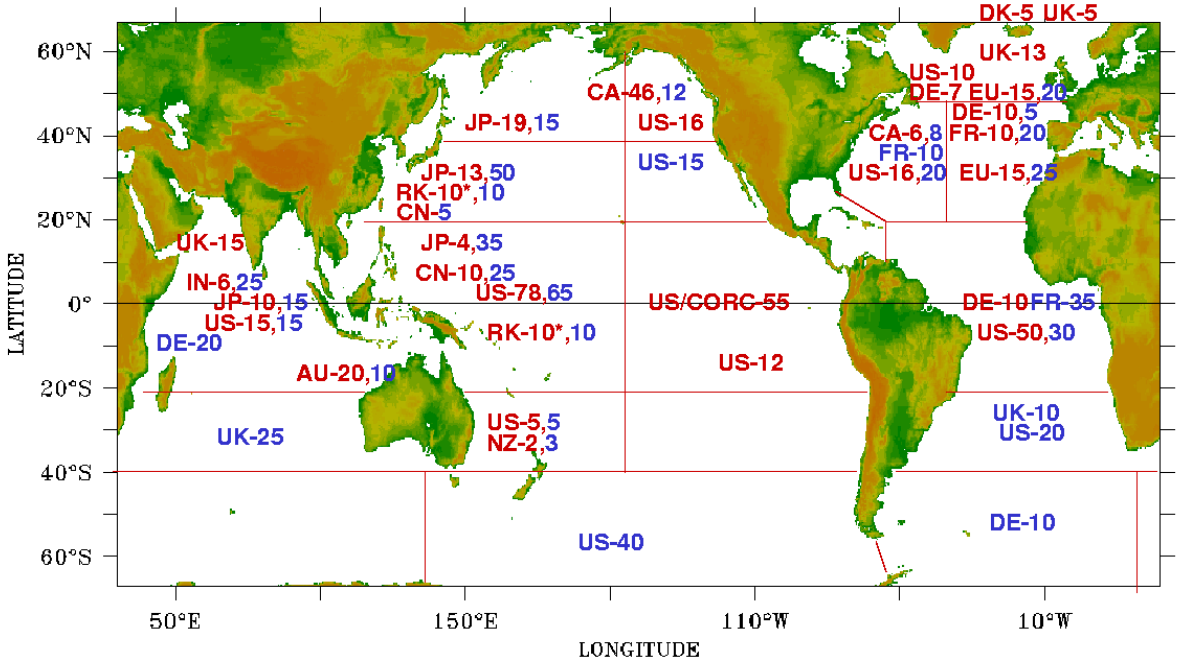


Figure 1: Target regions for funded floats planned for deployment by the end of calendar years 2001 (red) and additional floats for 2002 (blue). National plans shown are Australia (AU), Canada (CA), China (CN), Denmark (DK), France (FR), Germany (DE), India (IN), Japan (JP), Korea (RK), United Kingdom (UK), United States (US), and European Union (EU). Some additional floats are funded but not yet targeted and some deployment plans are tentative.

2.2.1. Atlantic Ocean

A report on the Atlantic Implementation meeting held in Paris in July 2000 was presented by Y. Desaubies. There are sufficient commitments to ensure that the Atlantic will be well covered by the end of 2002, at least north of 20°S. However, there appeared to be a need for adjustments in the planning for more efficient use of available resources. Several floats deployed by German

scientists in the context of specific research programs will transmit data available publicly, thus contributing to Argo objectives.

A small splinter group gathered to update and adjust plans (see Appendix 3). Several research cruises were identified from which floats will be deployed. Coordination and cooperation will continue.

2.2.2. Pacific Ocean

A report on the Pacific Implementation Meeting (Tokyo, April 2000) was presented by D. Roemmich. The meeting focused on consensus building among the Pacific nations contributing to the Argo project, and initial plans for float deployment were discussed. There are strong commitments for float deployment in the tropical Pacific, the northern Pacific and the western subtropical North Pacific (Fig 1). Additional attention is needed to see that adequate floats are provided for the eastern and southern portions of the Pacific basin. The total number of floats presently targeted for deployment in the Pacific is 280 by the end of 2001 and an additional 290 in 2002.

2.2.3. Indian Ocean

About 440 Argo floats are estimated to be the need for the Indian Ocean basin north of 30°S. The commitments of various float providers are as follows, through 2004 (with additional floats planned but not yet committed).

Australia: 20 (southeast Indian Ocean)
Germany: 20 (southwest Indian Ocean)
India: 150 (north of 10°S)
Japan: 50 (north of 20°S in the eastern Indian Ocean)
UK: 15 (western Indian Ocean, plus 20-30 floats along 32°S)
USA: 30 (tropical warm pool)

Further, Canada, China and France expressed their intent to deploy a few Argo floats in this basin; however, national decisions on these commitments are yet to be made.

2.2.4. Southern Ocean

There are plans to deploy a limited number of floats in the Southern Ocean (Fig 1), all in calendar 2002. These comprise up to 40 U.S. floats in the Pacific sector and 10 German floats in the Atlantic. The paucity of floats in the Southern Ocean is a recognized issue. A number of countries have plans for Southern Ocean deployments during subsequent years, and a strong focus of future planning activities will be float procurement for the southern hemisphere oceans. A scientific forum emphasizing the value of Argo and other broad-scale datasets in the southern hemisphere is recommended (to follow on the CLIVAR Southern Ocean workshop of November 2000).

2.3. The Argo Data System

Recommendations from the first meeting of the ad hoc International Data Management (DM) Group served as the background for the DM discussion. The principal objective of that meeting was to develop a standardized DM methodology for Argo. Participants at the DM meeting accepted this philosophy and worked towards establishing standards for formats, meta-data, data transmission and access, quality control, data exchange, data archiving, and data products. The results will appear in a DM Handbook the first draft to be available at the next DM meeting in June, 2001.

In addition, the DM group requested that the AST accredit the committee as an official subcommittee. This accreditation was granted. In addition the DM group's proposal for co-chair, Sylvie Pouliquen, IFREMER and Bob Keeley, MEDS, was accepted.

The AST generated several issues for consideration by the DM group at their June meeting including:

1) The definition and roles of regional data centers (as distinct from national and global centers), which are envisioned to provide the expertise necessary for integration of the national contributions in a given ocean basin.
2) Definition of interactions between PI's and data centers including data pathways.
3) Establishment of a list of Argo data centers.
4) Definition of who will develop and produce global data products.
5) Establishment of a timetable for DM accomplishments (e.g., when will data be available at the Global Data Centers, etc.)
6) Data tracking : liaise with the AIC to make sure that all floats deployed are accounted for and enter the data stream.

Finally, the AST was encouraged to forward ideas for consideration by the DM group to Molinari, Keeley and/or Pouliquen.

3. Technical Issues Review

A variety of technical issues of interest to Argo were discussed, as summarized below. It was agreed to form an internet Argo Technical Forum to disseminate technical information and to allow broad question/answer exchanges on technical issues. A splinter group met to establish this forum (with assistance of the Argo Information Centre) and to discuss technical issues in greater depth.

3.1. Salinity stability

Progress continues to be made in improving the quality of salinity measurements from profiling floats. Using SeaBird CTD sensors on floats, Riser and Swift (2001) examined the salinity data from nearly 60 float years of data collected on both Argo and non-Argo profilers in the Atlantic, Pacific, Antarctic, and the Japan and Okhotsk Seas. In general, it was found that in a local region, referenced to a deep temperature value, the float-derived values of salinity were more consistent with each other than they were with salinity derived from the climatology of the region. While in some cases the measured value of salinity on a deep isotherm varied by less than 0.01 PSU over times as long as 3 years on a float, the local variation in the historical data was several times larger. Perhaps this is due to long-term natural variability of the ocean that

cannot be captured in float records only 3 years long; alternatively, this could represent greater errors in datasets contributing to the salinity climatology of the region. From the existing float salinity data, this result seems to be consistent over most of the regions examined.

In the past year 3 floats with SeaBird CTD sensors have been recovered and recalibrated at the factory. From these recalibrations, the drifts in calibration can be assessed; all three floats showed very little change in calibration during their missions (one float was recalibrated after 3 years, and the other 2 after approximately 6 months in the water). The drifts of pressure, temperature, and salinity in all three cases were small (about 0.1 decibar, 0.0008 °C, and 0.001 PSU) compared to the original manufacturer's specifications for the instrument (2.5 dbar, 0.002 °C, and 0.005 PSU). Because of this, we have reason to be hopeful that sensor drift over Argo-type missions (4-5 years) will be within acceptable ranges.

Progess still needs to be made on some problems. Users of both SeaBird and FSI sensors report occasional difficulties with sensor drift and large discrepancies between float salinities and climatology, indicating that while the quality and duration of salinity measurements from profiling floats has greatly improved in recent years, there is still work to do in improving the reliability of salinity measurements in the context of Argo.

3.2. Delayed-mode salinity calibration

A system has been developed at PMEL by Wong, Johnson and Owens that uses historical hydrographic data to correct drift in salinity measurements from the profiling floats. An objective mapping technique is used to estimate the background climatological salinity field on standard potential temperature surfaces by using data from the World Ocean Database (1998). The float salinity data are fitted to the background climatology in potential conductivity space by weighted least squares with a time-varying slope. The error associated with estimating the background climatology is carried through in the weighted least squares calculations. Because of the need to accumulate a time series for calculating the slope correction term, this system is a delayed-mode system. Also, frequent in-situ hydrographic observations to the bottom of the float profiling depths at intervals less than the ventilation time scale are needed for accurate estimation of the contemporary background climatology. Other suggestions on how to determine sensor drifts include comparisons of float measurements with observations from fixed moorings or nearby floats.

3.3 Isopycnal floats

N.Shikama reported a result of isopycnal APEX floats designed to control their buoyancy to approach and maintain a target potential density range. This float measures temperature, salinity, and pressure every six hours and calculate potential density. If two consecutive potential density values are out of the target rangeσ_θ=26.7±0.1, the float increases or decreases its buoyancy. After the parking period of six days, it descends to 1000m from where it ascends measuring temperature and salinity profile up to the surface. Deployment of two floats of this type in the Kuroshio—Oyashio region in late February, 2001 reveals a fairly good float performance in approaching and maintaining the target potential density range.

3.4. Depth capability, energy budget/lifetime

Earlier discussion of the AST was reviewed. Although not all Argo instruments are capable of profiling from 2000 m everywhere in the global ocean, there are scientific objectives that make

such sampling valuable in addition to the objective of salinity recalibration using relatively stable (T/S) water masses. Profiling from 2000 m to the sea surface should be the Argo target, and the energy budget does not constrain deep profiling to occasional 10-day cycles.

3.5. Communications

Communications using Service ARGOS provides marginally adequate bandwidth for the Argo program. Vertical resolution is limited to approximately 60 points in the vertical, providing 10 m resolution in the upper layers and 50 m below the thermocline. This resolution is adequate when the data are used in short-term assimilation modeling, but is inadequate for some scientific applications. At present, Argos is a notional payload on the NPOESS generation of polar orbiting satellites.

There are several viable two-way, higher bandwidth systems available - however, these systems are designed and operated for commercial purposes. As a result their business practices and tariff structures have not to date been supportive for Argo or other oceanographic applications. The two leading candidates, ORBCOMM and Iridium have also not been economically viable. Both have now gone through bankruptcy, and there is uncertainty in the future of the reorganized companies. A problem is that oceanography is a minor user of any of these systems and we are reliant on external users over whom we have no influence. In either case, these systems can provide orders of magnitude improvement in the amount of Argo data transmitted per float cycle, while at the same time minimizing the time spent on the sea surface and the time interval between data collection and data center reception.

In the U.S., two (small business initiative) grants have been awarded for the development of Iridium-based systems. One will complete the development of a remote terminal while the other will develop the infrastructure for the complete system. The system will be two-way and is expected to operate at 10 kilobit/second. A prototype modem for use in autonomous instruments should be available at the end of 2001 for testing.

The major issue for improved data communication for Argo and other oceanographic programs is political and financial, both beyond the scope of the Argo program. We would, however, like to strongly encourage the funding agencies and international commissions that support Argo in their efforts to find a solution to this important problem for oceanography.

4. Global implementation issues

4.1 The Argo Information Centre

Etienne Charpentier reported on the actions taken following IOC Resolution XX-6 (concerning international notification of float deployments) and on the establishment of the Argo Information Centre (Appendix 4). The new Argo Coordinator, in charge of the operations of the Argo Information Centre in Toulouse, Mr. Mathieu Belbeoch, was hired in February 2001 thanks to contributions from Canada, France, UK and USA. The Science Team agreed that this was an important position for the program and discussed the role of AIC and the Coordinator. The AST agreed that the AIC should undertake the following tasks as a priority:

- Collecting float positions from float operators in order to implement an online float tracking system (as required by IOC Resolution XX-6) and produce regular status reports and maps, all accessible via the AIC web site. The meeting therefore urged the float operators to

provide authorization for the AIC to access Argo data at the ARGOS centre and to take steps to provide AIC with float positions from those floats reporting through other telecommunications systems.
- Provide information on the AIC web site regarding practical steps required before and after deployment of floats (e.g. obtaining WMO numbers, ARGOS registration, deployment notification, …)
- Coordinate deployment opportunities and provide information on such opportunities via the web.

4.2 Capacity building/ SEREAD

Bill Erb, IOC Perth Regional Programme Office, presented SEREAD, Scientific Educational Resources and Experience Associated with the Deployment of Argo Drifting Floats in the South Pacific Ocean. This project, announced via a press release earlier this month, will involve secondary school students from selected Pacific Island nations in monitoring floats and viewing float data via the Internet. The scientific aspects of the Argo programme will be formulated into lessons for delivery by teachers at six schools initially and a larger number later. SEREAD is coordinated by Prof. Than Aung at the University of the South Pacific node of the International Ocean Institute, located in Fiji, and is presently funded by seven organizations providing US$3000 each. The AST emphasized the importance of scientific input and review of materials developed. Further the AST agreed on the importance of participating in capacity building initiatives, which may be broader than Argo, e.g., GODAE. The Argo Information Centre may be able to assist SEREAD. If well-accepted, the SEREAD concept can be readily adopted in other regions or individual countries.

4.3 Regional Action Groups/ EEZ issues

The implementation of Argo is intrinsically a multi-regional endeavor, whose coordination will lead to a global array. The network will be successful only if there is broad agreement on float deployments within EEZs by the EEZ nations as float providers and/or by partnering with float providers. The IOC Resolution adopted in 1999 (Resolution XX-6) addressed the issue of Argo floats that may drift into EEZs but not those that are deployed within EEZs. Because a large fraction of the western tropical Pacific includes national EEZs, and because of the potential value of data in the region for seasonal-to-interannual prediction and increased scientific understanding, attention has first been directed to securing consensus on float deployments in this region. S. Wilson described the plan, which has been proposed for the central and western Pacific Ocean and the experience to date. Most of the 20 island countries have concurred, through the support of the regional South Pacific Applied Geoscience Commission (SOPAC), with plans for floats to be deployed within EEZs. The remaining concurrences are pending. In return, float deployers have the responsibility to notify countries of planned deployments, through the Argo Information Center, and to help ensure that Argo data can be exploited for the benefit of all nations.

It is critical that AST members become involved, to explain to their own governments the importance of Argo to their national interests, in order to encourage access to EEZs. Currently the assistance of France, U.K., Japan, Australia, and New Zealand is needed to obtain this concurrence in the western Pacific. It should be noted that the U.S. is willing for any country to deploy Argo floats in its EEZ and collect the resulting data—without prior notification.

When seeking concurrence, it should be noted that Argo is an international program, implemented under the auspices of the IOC of UNESCO and the WMO, as a component of the Global Ocean Observing System. The AST will coordinate among the members to attempt to resolve potential EEZ difficulties. The most important factor in obtaining concurrences is the active involvement of the country in the Argo project and its appreciation of the value of Argo applications.

4.4. Float retrieval plan

The team agreed that a float retrieval plan is needed for three reasons.
1. There is scientific interest in recovering floats for post-calibration of CTD sensors.
2. There is a small but finite safety risk if expired floats are opened by untrained personnel.
3. There are perceived adverse environmental effects of expired floats.

While floats have been carefully designed to minimize safety risks and while environmental consequences are considered negligible, the team agreed on the need for a consensus statement addressing associated safety and environmental issues. In addition, the team agreed to place a label on each float, in multiple languages, with a unique serial number and instructions for notifying the Argo Information Centre of the float location. Each float provider must accept the responsibility for arranging for the packaging and safe return of any floats found. This number is expected to be small. Most floats will end their useful life in deep water, eventually sinking to the ocean bottom.

4.5. Argo informational materials

The importance of Argo explanatory materials cannot be overestimated. Reference was made to the CD-ROM and mini-CD produced last year by U.S./NOAA, which includes several data products, a float animation, and a powerpoint presentation on Argo. It would be very beneficial to have graphical materials from countries beyond the U.S., and preferably in languages other than English. NOAA plans to update its CD and has offered to make it a multi-national presentation. A number of opportunities are forseen in the near future to distribute Argo materials including a UN Consultation on the Oceans and Law of the Sea (New York, 7-11 May), the first meeting of the IOC-WMO Joint Commission on Oceanography and Marine Meteorology (JCOMM, Iceland, 19-29 June), and the biennial IOC Assembly (Paris, 2-13 July). Korea has prepared a color brochure and the U.K. has a color handout. Spain and India plan to produce Argo handouts in Spanish and Hindi, respectively. Members were requested to provide electronic material to NOAA by April 7. Handouts for the UN Consultation can be sent to NOAA also, by May 1.

The presently-used Argo logo was discussed. Although it depicts a Viking rather than a Greek ship, the team preferred to retain the present logo. The Argo Information Centre will provide a version with better clarity.

5. Next meeting, membership

The AST is an informal group, constituted by the CLIVAR Upper Ocean Panel and the GODAE Steering Team. Membership is open to those who are experts in float technology and who represent countries that have purchased or built Argo floats of those with advanced plans for float procurement or production. With the addition of several new float-providing countries during the past year, the size of the AST is increasing. The AST membership should continue to evolve on an inclusive basis as new national plans are formulated. Because of its increasing size, the team agreed to form an executive committee, to work primarily via e-mail, to be headed by the chairman and to include representatives from North America, Europe, Asia, and the Southern Hemisphere. Y. Desaubies and H. Freeland were selected, with representatives from Asia and the Southern Hemisphere to be decided in the near future.

The next meeting of the full Argo Science Team (AST-4) will be held in Australia in early 2002, not to conflict with other relevant activities in the same period. In the interim, the Indian Ocean implementation meeting will be held in Hyderabad, India in late July 2001. The team also tentatively accepted an invitation from China to hold the AST-5 in China in 2003.

Appendix 1: National Reports

1.1. U.S.A. (D. Roemmich, B. Owens, S. Riser, R. Molinari)

The U.S. Argo Project is supported through the multi-agency National Ocean Partnership Program (NOPP). The project is presently carried out by a U.S. Float Consortium that includes principal investigators from five institutions (SIO, WHOI, UW, NOAA/AOML, NOAA/PMEL). Float production, deployment, and data system functions are distributed among these institutions on a collaborative basis.

In the first two years of U.S. Argo (FY99, FY00), a total of 187 floats were funded through NOPP, together with technology improvements and development of the data system. It is planned that all of these floats will be deployed by the end of this year – 76 in the Atlantic, 96 in the Pacific, and 15 in the Indian Ocean. Atlantic deployments are concentrated in the tropics and western subtropics. Indo/Pacific deployments are concentrated in the tropical warm pool region. An additional 35 FY00 Argo floats are funded through the NOAA Consortium on the Ocean's Role in Climate (CORC), to be deployed in the central and eastern tropical Pacific, and 36 FY00 Argo floats are funded by the Naval Oceanographic Office. The total of U.S. Argo floats for FY99/00 is 258.

A nascent U.S. Argo Data Center is now in operation at NOAA/AOML. Real-time data from all U.S. Argo floats are presently being transmitted via the GTS. A system for salinity recalibration has been developed at NOAA/PMEL. Additional elements of the delayed-mode QC system are still under development and a transition of the real-time QC and GTS transmission to an appropriate round-the-clock operational agency is planned.

In FY01, U.S. Argo enters its 5-year full implementation phase with competitive proposals to NOPP submitted March 16, and work to begin about July 1, 2001. At the present time, only the first year of funding is appropriated, and this is expected to provide approximately 150 floats through NOPP. An additional 20 FY01 Argo floats are funded through CORC and 20 more by the Naval Oceanographic Office, bringing the FY01 total to 190 U.S. Argo floats. The U.S. Argo effort is planned to ramp up to more than 300 floats per year by FY03, subject to available funds. Technical developments will be ongoing.

Regional priorities for deployment of Argo floats are set by a U.S. Argo Advisory Group, composed of float providers plus agency representatives and representatives of the Argo user community – NCEP, FNMOC, NODC, CLIVAR, GODAE etc. Criteria for targeting U.S. float deployments are:

- Build a global Argo array with international partners.
- Rapidly implement regional arrays that are high priority to users (e.g. the warm pool region and western subtropics)
- Build on existing (pre-Argo and early Argo) float arrays.

1.2. U.K. (J. Turton)

The UK's contribution to Argo is being funded by the Department of the Environment, Transport and the Regions (DETR), the Ministry of Defence (MoD) and the Natural Environment Research Council (NERC), and is managed on their behalf by the Met Office. Southampton

Oceanography Centre (SOC), the British Oceanographic Data Centre (BODC) and the UK Hydrographic Office (UKHO) are all participating in the project.

The UK Argo Project

During the past year the UK Argo Project was formally initiated. The aims of the project are (i) to establish an operational capacity to deploy (by various methods) about 50 floats each year (thus maintaining about 150 to 200 floats in the water at any one time), (ii) to apply all real-time float data in operational ocean forecasting, and (iii) to process the UK float data in delayed mode for climatological use. The Met Office are responsible for (i) and (ii), whilst SOC, BODC and UKHO will undertake (iii). It is expected that, following completion of the project in 2003, there will be a longer-term commitment from DETR and MoD for the continued funding of Argo floats. At this stage the longer-term funding (beyond FY02/03) for Argo has not been agreed and will be subject to DETR and MoD approval.

Through the UK Argo Project we have procured 13 floats under FY00/01 (April 00 to March 01) funding and will be procuring 50 floats in each of FY's 01/02 and 02/03. Over the next 2 years these floats will be supplemented by, perhaps as many as, 25 NERC "research" floats, subject to successful bids for funding. While these research floats may have a non Argo standard mission profile, they will be co-ordinated with and contribute to Argo.

Project Management and Co-ordination

The UK Argo Sponsors Steering Committee (composed of the funding agencies - DETR, MoD and NERC) determines the funding, objectives and implementation policy of the UK component of Argo. The UK Argo Project Board has formal responsibility for the project and monitors and reviews progress, it reports to the funding agencies on progress and associated matters. The UK Argo Expert Group has been established to act as a national focus for providing specialised scientific and technical advice in support of the UK Argo Project and the International Argo Programme. It provides expert advice and raises issues, as necessary, for consideration by the Project Board. It is a sub-group of the IACMST (Inter Agency Committee on Marine Science and Technology) GOOS Action Group, to which it reports on its activities.

Progress During the Last Year

13 floats have been procured during the last year. 5 of these (Webb Apex) floats were deployed in the Irminger Sea in January. The deployments were from a volunteer Icelandic cargo ship using a "free-fall" deployment method. This is an adaptation of the Webb air-drop package to allow floats to be launched from deck level on a moving ship by the regular crew, using a slide similar to a "burial-at-sea". 5 MARTEC PROVOR floats will shortly be deployed in the same region. MARTEC have developed for us a deployment crate to allow the PROVOR floats to be deployed in a similar fashion. These floats will comprise a pilot UK Argo array for which we aim to evaluate the floats (deployability, data quality (with particular emphasis on salinity)) from the 2 manufacturers. A further 3 Webb Apex floats will be deployed by SOC in late May/early June in the north-east Atlantic (Rockall Trough).

Real-time data from all these floats are (or will be) posted onto the WMO GTS, via CLS/Meteo-France for the Apex floats and via Coriolis/Meteo-France for the PROVOR floats. In addition, real-time (temperature only) data from the 4 surviving SOC PALACE floats (launched in 1996) will shortly be available on GTS via the Met Office.

Future Plans

We have recently ordered 20 floats for deployment this year. The majority of these will probably be deployed from RRS Charles Darwin which will be operating in the western Indian Ocean from May. 5 of these floats will be deployed in the Arabian Sea/Gulf of Oman. Recent climate simulations made by the Hadley Centre for Climate Prediction and Research have suggested that a freshening in the southern Indian Ocean intermediate waters is a signal of man-made climate change. Therefore, in early 2002, we aim to deploy from Darwin 20 to 30 floats along the 32° section in the southern Indian Ocean.

Other areas where we are looking to deploy floats are the South Atlantic (10 in each of 01/02 and 02/03), the eastern Mediterranean (5 in 01/02) and the Southern Ocean (in 02/03). A number of floats have also been set aside for 01/02 for the Norwegian Sea and the north-east Atlantic; regions for which there is an operational requirement for real-time data and will be deployed if there is a shortfall of real-time Argo data for these areas.

The Southern Ocean is of crucial importance to the circulation of the global ocean and is a priority area for NERC science. A proposal has been made for the establishment of a Southern Ocean regional Argo Data Centre at BODC.

Issues

The availability of real-time Argo data over the GTS is a key issue for the UK. Real-time data are needed to improve ocean analyses and predictions from our operational FOAM (Forecasting Ocean Atmosphere Model), which is run routinely on a daily basis. We have identified around 500 floats currently operating, but are only receiving real-time data from about 44% of these. About half (54%) of these data are being received within 2 days of validity time, but many (27%) are arriving too late (after 10 days) to be assimilated into FOAM. There would be immediate benefits if more of the existing float data were available on GTS and timeliness were improved.

1.3. Spain (G. Parrilla)

Although 3 Spanish institutions (Instituto Español de Oceanografía, Universidad de Las Palmas de G.C. and Instituto de Ciencias del Mar de Barcelona) are partners in the European contribution to Argo: Gyroscope, it does not exist yet an official national plan for Argo in Spain.

Presently, it is in the phase of formation a group of persons from oceanographic institutions, universities and other non marine and non-research agencies, but able to profit from the Argo information, for requesting funds to the Spanish funding agency to acquire and launch some 24 floats in the Atlantic.

Officers at the Ministry of Science and Technology have been approached about the Argo national funding and, at first, they have been receptive to the idea. A document is been prepared for them to review as a first step in the process of preparing a formal proposal. Plans are to have it submitted before the next 3 months and have the evaluation results some 6 months after submission.

From the above mentioned group is expected to create a National Argo Committee with the main goal of pursuing a longer-term commitment of Spain to the deployment of global Argo array.

Also it will be explored the opportunity of manufacturing or assembling, in the future, the floats in Spain.

1.4. Russia (Y. Volkov, M. Danchekov and V. Yakukhin)

International Argo project represents a big interest for Russian marine organization. Special interest is in the use of float data for operative purposes – meteorological and oceanographic forecasts. Russia as a member of the World Meteorological Organization voted for this project.

1. Hydrometeorological Agency is responsible in Russia for this project. Far Eastern Regional Hydrometeorological Research Institute (FERHRI) of this agency has the experience with such floats. By FEHRI 4 PALACE floats wre deployed in the Japan Sea in last 2 years.
2. FEHRI proposed to deploy 2 more PALACE floats in next year. Hydrometeorological Agency of Russia proposed to use for deployment of floats two of its research vessels in nearest 2 years. One vessel will go in September of 2001 from Vladivostok to Antarctic, another one in February of 2002 – from Saint Petersburg to Antarctic.

1.5. New Zealand (P. Sutton)

Argo is being implemented and supported in New Zealand by the National Institute of Water and Atmospheric Research (NIWA). The contact person is Philip Sutton.

New Zealand currently has funding to purchase 2 floats in mid-late 2001. It is hoped to purchase 10 floats over the next three years. The floats will be deployed in the New Zealand region, with the initial deployments being in the Tasman Front area northwest of New Zealand (28-33°S, 164-178°E). It is intended to deploy up to 8 USA floats on the same research vessel cruise. Future New Zealand deployments will focus in this area and in the New Zealand subantarctic zone: 44-55°S, 170°E-170°W.

New Zealand's largest contribution to Argo is likely to be in terms of logistical support. NIWA's 72m research vessel, "Tangaroa", can be used as a platform for Argo deployments, and routinely covers most of the New Zealand EEZ with occasional transits to Antarctica/Ross Sea. In addition, New Zealand is able to supply logistical support for other South Pacific deployments. This support could take the form of supplying or training personnel, float delivery, preparation and maintenance and the promotion of Argo throughout the South Pacific.

1.6. Korea (Kuh Kim)

Korean Meteorological Administration (KMA) under the Ministry of Science and Technology and Ministry of Marine Affairs and Fisheries (MOMAF) established jointly Korea Argo Subcommittee (KAS) under Korea Oceanographic Committee to carry out Argo-related projects in Korea October 2000. KAS is composed of members from KMA, MOMAF, Korea Ocean Research and Development Institute, National Fisheries Research and Development Institute, National Oceanographic Research Institute and experts in Argo from university.

KAS has been provided with the fund to purchase and deploy about 20 profiling floats in 2001 in seas around Korea and the western Pacific Ocean. KMA and MOMAF will try to secure the national budget to increase to 30 floats each year.

1.7. Japan (K. Takeuchi)

1. Funding

The Japanese Argo Project is funded in a program called “Millennium Project” which is a 5 year program starting from FY 2000. The main target of the project is improvement of long-term weather forecast. Agencies involved in this project are Japan Meteorological Agency, Hydrographic department of the Japan Coast Guard, JAMSTEC and FORSGC. The JMA is responsible for the real-time data management, while the Coast Guard contributes by observation by other method for inter-comparison with Argo measurement. The JAMSTEC and FORSGC are responsible for the float deployment and for the delayed mode data management.

2. Scientific Targets
    1. Upper ocean variation associate with decadal variation.
    2. Circulation of subducted water and its role in the decadal variation.
    3. Formation and circulation process of the North Pacific Intermediate Water.
    4. Formation process of the Subtropical Mode Water and its year-to-year variations.
    5. Interaction between the subtropical gyre region and tropics and its effect on ENSO.

3. Preparation Stage

In the preparation stage (FY2000 to FY 2001), the following tasks are carried out.

1. Study of float distribution, Logistics
2. Establishment of Sensor Calibration System
3. Study of float deployment from VOS
4. Study of ecological float termination
5. Development of data handling system
6. Development of data quality control method
7. Development of data assimilation technique
8. Test deployments near Japan

4. Deployments of floats

In FY 2000, we put 17 floats in water as tests in the Western North Pacific. In FY 2001, we are planning to put 84 floats in the Western North Pacific, and 10 in the Eastern Tropical Indian Ocean.

5. Data distribution

All the data taken by Japanese floats are put into GTS. The data are available also at the Japan ARGO web site (http://goos.kishou.go.jp/argo/).

6. Forum for Deployment and Operation of Argo Floats

For better understanding of the international and Japanese Argo projects, the meeting is held from March 5 to 9, 2001 in Yokosuka , Japan, inviting representative from 15 coastal countries in the Western Pacific and Indian Ocean.

1.8. India (K. Radhakrishnan)

1) Organization of the Indian ARGO Programme

(i) The Government of India has approved the implementation of ARGO Programme India. The Department of Ocean Development (DOD), Government of India is the nodal organization for the Programme.

(ii) The overall responsibility for the implementation of the Programme at the Institute level has been assigned to the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad.

- In addition to coordinating with the participating Institutes, INCOIS is specifically responsible for the Data System including the necessary data reception/communication system and interface with other National/International Agencies for exchange of Data and data products.

- The National Institute for Ocean technology (NIOT), Chennai has been assigned the responsibility for the Float component, including the procurement, technology acquisition and deployment.

- The Centre for Ocean and Atmosphere Sciences (CAOS) in the Indian Institute of Science, Bangalore orchestrates the Data Assimilation and Utilization and coordinate the science component with the National Institute of Oceanography (NIO) and another 6 Research/Academic Institutions.

2) Scope of the Indian ARGO Programme

a) Deployment of about 150 profiling Floats in Indian Ocean- North of 10^{o} South during 2001-2005;
b) Technology Acquisition and Production of Floats in India
c) Reception of Data in India and setting up of ARGO Indian Data Centre
d) Dissemination of Data and Value-added Products
e) Assimilation of Data in Indian Programmes (e.g. BOBMOX, ARMON, Weather Forecasting, Ocean State Forecast)

1.9. Germany (U. Send)

The German Ministry for Research and Technology (BMBF) has finally stated a willingness to fund an ARGO pilot phase, after the ministry of transport (in charge of operational agencies like the weather service and the hydrographic service) acknowledged now that they would have an interest in and use for data from a program like ARGO. As a result, the coordinator (F.Schott) of the national proposal which was submitted more than a year ago has been informed by the Research Ministry (BMBF) that this proposal would now have a chance of formally being considered for funding.

The downside is that the ocean research division of this ministry has come under extreme fiscal pressure, since the construction of a new research vessel will need to partially come from the ocean research budget for the next 3-4 years, without any extra funds being made available

either for the vessel or for ARGO. Since the same budget pays for CLIVAR, this may result in a funding choice or split between CLIVAR, ARGO and the vessel.

In other words, the ARGO idea and plans are now favourable received with the relevant ministries and agencies, and a willingness to fund exists, but it is not clear whether, at what level and when funding actually can take place.

Independent of ARGO, various groups in Germany have profiling floats in the water and have plans to continue with such efforts, largely funded through individual project proposals, as follows.

- Along 46N in the Atlantic, BSH (Koltermann) currently has 18 floats running in the vicinity of the mid-Atlantic ridge, all with T/S sensors. During 2001 another 5 will be added to this. All data from these floats are already on the GTS and will remain to be so.

- AWI (Fahrbach) currently has 15 T-only floats operating in the Weddell Sea, 10 launched in Dec 2000, the others in spring 2000 (750m depth, 1 week repeat). Some losses expected soon due to ice growth. Not available in real-time. 10 new T/S floats will be launched in 2002/2003 in the southwestern Atlantic (Drake Passage and surroundings). These will profile from 0 to 2000m and the data will be available in real-time.

- In the subpolar North Atlantic there are currently 15 floats operating from IfM Kiel (Schott), T-only, deployed in 1997, 1500m depth. Data not public. Another 7 will be added in summer 2001 with T/S sensors, also 1500m, 10 day cycle, these data will be public.

- 15 T/S floats have been deployed in the tropical Atlantic in 2000 by IfM Kiel (Schott) with a parking depth of 200m and 400m, but profiling to 1500m, 10 day cycle. These data will become public in the future.

- A proposal has been submitted for 20 T/S floats for the southwestern Indian Ocean (IfM Kiel), parking depth 200m, profiling to 1500m, 10 day cycle. If funded, these data would also become publicly available.

1.10. France (Y. Desaubies and P.Y. Le Traon)

Introduction

French activities related to ARGO are coordinated under a national project dubbed CORIOLIS, whose general objectives are to enhance capacity to collect, validate and distribute in real time global *in situ* ocean data. Several agencies contribute to CORIOLIS : CNRS[1], Ifremer[2], IFRTP[3], IRD[4], Météo France, and SHOM[5], with several actions which are not limited to ARGO (XBT lines, PIRATA array, surface drifters, thermo-salinometres, for instance). Close links with the MERCATOR project (global real time data assimilation in ocean models) are maintained.

[1] Centre National de la Recherche Scientifique
[2] Institut de Recherche pour l' Exploitation de la Mer
[3] Institut Français de Recherche et de Techniques Polaires
[4] Institut de recherche pour le Développement (formerly ORSTOM)
[5] Service Hydrographique de la Marine

The leadership for ARGO participation has been taken by Ifremer , with contributions from CNRS and SHOM. It is not seen as an open ended commitment with recurrent funding, but a demonstration and feasibility experiment for the period 2000-2005. Actions related to ARGO include setting up a data service, technological development of profiling floats, scientific studies (sampling strategies, parameter definition, array performance, mapping), and field work The French ARGO and the EU GyroScope projects are closely related.

The CORIOLIS project director is Ms. S. Pouliquen, oversight is through a scientific committee, and an executive board.

Float deployments

Funding for some 250 floats has been identified over the years 2000-2002 (including 40 EU- funded GyroScope floats to be deployed by French participants), which will be deployed from 2001 to 2003.

During the ARGO Atlantic Implementation meeting (held in Paris in July 2000), France identified the Atlantic ocean as its first priority, in pace with the development of the MERCATOR models. Deployments will proceed from north to south in the years 2001 to 2003, in accordance with the commitments given at the meeting (about 200 floats, half of which south of 20°N). Most deployments will be from research vessels of opportunity (PIRATA array maintenance for instance).

The remaining floats could be targeted for the Indian ocean (2003), where interest has been expressed by several laboratories, and deployments opportunities are afforded by the RV Marion Dufresne.

Data service

The CORIOLIS data centre in Brest is presently running in a preliminary, prototype version (V0); an improved version (V1) will be fully operational in mid – 2001.

It will handle all PROVOR –type floats, as well as data sets from others float types (Webb Research APEX), on request. Technical information on floats are delivered to the PI's by mailing lists. Data distribution is done via GTS or web and ftp sites. Other in situ vertical profiles (XBT, drifting buoys, …) are available on the site, as well as data products (such as objectively analysed fields over the North Atlantic).

As one of the ARGO global data centres, the centre in Brest provides access to the global data set. It coordinates activities such as QC procedures, filing conventions, data-holding comparisons.

Technological development

The development of the PROVOR float is progressing. A temperature only version is available and presently operating in the POMME experiment (centred at 42°N, 20 °W). Prototypes equipped with FSI CT sensors, deployed in April and September 2000, are presently under evaluation. Slightly modified versions, equipped with either SeaBird or FSI sensors (conductivity and temperature) are to be tested in early to mid – 2001 , with first deployments after validation.

Other

IFREMER hosted the ARGO Atlantic Implementation meeting, held in Paris in July 2001; and the International ARGO Data Management meeting, held in Brest in October 2000.

France is contributing (9,150 €/yr) to the funding of the IOC ARGO Information Centre in Toulouse.

1.11. E.U.-funded Gyroscope project (Y. Desaubies)

Introduction

The GyroScope project has been funded by the European Commission, under the Key Action *Global Change, Climate and Biodiversity* of the 5th Framework Programme. The project is funded for three years, starting in January, 2001. Nine laboratories, from France, Germany, Spain and the UK.[6], participate. The total budget of 4.9 M€, with EU contribution of 2.9 M€, will finance about 80 floats as a contribution to ARGO .

Objectives

The general objectives were presented at the IAST – 2 meeting in Southampton (March 2000). Briefly stated, the objective of the GyroScope project is to develop a European component of a global in situ observing system of ocean variability in the North Atlantic. The first objective is to deploy a pilot array of 80 autonomous profiling floats, as a contribution to the ARGO international programme. The data will be used to estimate the time varying ocean circulation, temperature and salinity fields, and the balance of heat in the North Atlantic. Some of the estimations will be done in real time ; other will include complementary data sets (satellite altimetry) to obtain the most accurate estimates and assess the information content of the float data (resolution, accuracy). Recommendations will be made for future implementation of an in situ ocean observing system.

Strategy for deployments

During the first project meeting, held in Brest, February 1 and 2, 2001, the strategy for float deployments was one of the main topics of discussion. It was decided to deploy floats of different manufacturers (APEX and PROVOR), with FSI or Sea Bird sensor packages, with the view to establish comparisons. Production delays mean that the first float deployments will start in June 2001, with only a few instruments (order 10 to 15). Thereafter, deployments will continue, with the objective to have all the GyroScope floats in the water by mid-2002, i.e. mid-way through the project.

The field work is the responsibility of LPO and CMO (Brest), IFM (Kiel) and IEO (Madrid/ Santander). Deployments will be mostly from research vessels; several cruises have been identified at the meeting. A preliminary planning was agreed upon, with the understanding that it would be co-ordinated with other national plans.

[6] In France : LPO/Ifremer/CNRS (Brest), CMO/SHOM (Brest and Toulouse), CLS (Toulouse) ; in the UK : SOC (Southampton), Met Office (Bracknell); in Germany : IFM (Kiel) ; in Spain : IEO (Madrid and Santander), ICM/CSIC (Barcelona), University of Las Palmas (Gran Canaries).

Other objectives

Most of the other objectives of the project are dependent on having floats in the water. The various analysis will include GyroScope-funded, as well as other international ARGO floats.

The proposal is structured in WorkPackages (WP), a brief description of which is given here. WP1 concerns all activities leading to the actual deployment of the floats at sea. WP1 includes array design by simulation of float sampling in a high resolution ocean circulation model ; experiment planning ; instrument purchase, preparation, testing, calibration, programming ; and field work on ships. WP2 is a follow-on activity of technical monitoring and evaluation of instrumental performance. WP3 relates to the CORIOLIS Data Centre that will implement and operate the data management. WP4 and 5 pertain to different approaches to estimating the fields observed by the array and its information content. WP4 will more specifically explore how to use low resolution profiling float data in combination with altimeter data in high resolution ocean model data assimilation systems. A finite-difference inverse model will be used to combine altimeter and profiling float data with surface flux data and assess the relative contributions of the data sources. WP5 will develop real time products, and data synthesis for visualisation and distribution on the project web site. The techniques will include mixed layer modelling combined with a circulation model, combination with altimeter data, and inverse modelling. The WP6 concerns all scientific analysis of ocean processes, for the period of the experiment : heat and fresh water budgets of the North Atlantic : air-sea exchanges, transports and storage over a two year period, mixed layer and water mass characteristics, water mass formation and subduction. The recommendations for future implementation of ocean observing system (WP7) will be based on the results from the previous work packages, as well as on technical and economic factors.

1.12. China (J. Xu)

China's Attitude to the Argo Project

Since the Argo project was come out, Chinese ocean policy-makers and administers have paid more attention to it, and state on many occasions that China would positively consider participating the project and make the Chinese scientists' contribution to it. Then, many atmosphere experts and oceanographers have expressed their strong interest to use profiling floats in their projects.

Organization

In the past year (2000), the State Oceanic Administration (SOA), Chinese agency responsible for the ocean affairs, did much substantial work, including to introduce government officials and cross-agencies the contents about the Argo project, its significance of the Argo implementation and its active influence to the mankind activities. And after several times coordinating and demonstrating about the Argo act plan and its funds source, a main common understanding is reached. China will be set up the related groups to manage the China contribution to Argo.

Funding

In China, funding for Argo will come from three main channels, that is, the National Basic Research Programme, the National Climbing Programme and the National Special Projects. In

the coming three years, China will be planned to deploy about 80 profiling floats(2000m depth) in the regions of the South China Sea and the Northwest Pacific Ocean, as well as the adjacent oceans, totally investing Chinese RMB Twenty Millions yuan (20,000,000).

Projects

At the moment, two projects related with Argo have been planned in China. One is the Research on the Formation and Variation Mechanism and Numerical Prediction Theory of the China Coastal Circulation and Its Influence on Coastal Environment (1999-2004). The other is the Research on the Formation Mechanism and Prediction Theory of heavy Climatic and Synoptic Disasters in China (1998-2003). The latter will study the theory of monitoring, dynamics and prediction of the ENSO, they are planning to deploy 8-10 profiling floats in the areas where the Western Pacific Warm Pool and the Kuroshio origin, started in the summer of 2001. The fund comes from the National Basic Research Priorities Programme supported by the Ministry of Science and Technology.

Development

A Chinese marine technical institute is to develop profiling floats under the support of the mature technique. But, the first sets of profiling floats, which will be deployed soon, will be imported from abroad. In the future, China also would plan to import the main parts of the float and assemble them at home, in order to reduce the costs of profiling float and lessen possible breakage and technical hitch caused by long distance transportation.

1.13. Canada (H. Freeland)

The Canadian contribution to Argo is presently supported exclusively by a single Government Department, the Department of Fisheries Oceans, though this may change shortly. Since IAST-2 in Southampton the Canadian involvement in Argo has gained enormous momentum and we are prepared for a significant contribution during the upcoming field season.

a) The Acquisition of Hardware.

Canada has taken delivery of 18 APEX-SBE floats (as of March 1st 2001) and will have a total of 52 available by the end of the current fiscal year (fiscal year ends on March 31st 2001). These floats are expected to be deployed as a national contribution to Argo during 2001.

b) Deployment Locations.

As stated at previous meetings Canada has enormous interest in seeing the north Atlantic Ocean adequately instrumented. However, we are also aware that a large number of other countries expect to launch floats in the N. Atlantic. At the present time Canada is retaining 6 floats for deployment in areas of the N. Atlantic that might appear to be being missed by the deployments of other nations. Should a large area of interest to Canada be missed, we will address this problem. For this reason Canada is highly supportive of the policy that floats are free to drift anywhere and report data publicly, this is in accordance with the IOC Resolution XX-6. The result is that most Canadian deployments will be in the Gulf of Alaska during our 2001 field seasons. The first deployments that will be formally designated as Canadian Argo deployments should take place in May 2001.

c) Data Processing.

Canadian floats will report through Système ARGOS and the resulting data routed to MEDS, the Marine Environmental Data Service in Ottawa, Ontario. The data will be received every 6 hours, processed automatically and subjected to automated data quality control, then transmitted on the GTS and posted for international access on the WWW. As in the US additional elements of a delayed-mode QC system are still under development. The Canadian data handling schemes are being constructed under the guidance of the Argo data management committee and will match and parallel other national schemes.

d) The Future.

It is expected that in the future Canada will contribute to the deployment of the global Argo array, indeed it appears likely that Argo will be a vehicle whereby Canada develops a credible southern ocean observing program. However, deployments remote from waters of particular Canadian interest will not occur until 2002 at the earliest.

e) Funding Concerns.

At the present time the funds required to track Canadian Argo deployments have been identified but not secured. However, this is under aggressive scrutiny, and there is good reason to believe that this problem will be resolved before the start of the new fiscal year. Specifically, it is anticipated that Argo operations will be funded through a special interdepartmental fund though future capital purchases will probably continue to belong primarily to the Department of Fisheries and Oceans.

f) Manufacturing.

Canada notes that the global manufacturing capacity for floats remains inadequate. As one example, another Canadian Government Department was recently unable to purchase floats as production commitments offered no opportunity for new production before March 31st. A Canadian company (Metocean) is close to having established a production capability for Argo floats and should be considered as a candidate supplier for any nation.

1.14. Australia (S. Wijffels)

Pilot Array Status:

The deployment of a 10-float pilot array in the South Eastern Indian Ocean between Northwest Australia and Indonesia has been completed. The array was funded by a Special Executive Grant from CSIRO. The floats, all Webb Research Corporation R1-PALACES, are profiling to 2000m and return ~50 points. The first 4 floats deployed were programmed by WRC and failed to measure through the thermocline. Floats subsequently deployed were programmed at CSIRO and, to lengthen their life, energy was added by replacing some of the alkaline batteries with lithiums. So far these floats are working well and returning data from the whole water column. A mixture of research, Australian Navy and commercial ships of opportunity were used to deploy the floats.

All floats are instrumented with Seabird Electronics CTDs. The first 4 deployed suffered from contamination by leaking antifoulant plugs. After roughly 6 profiles this problem appeared to

rectify itself. Of the remaining 6 CTD's one has shown radical changes in calibration over the last 5 profiles. The cause of the latter is not known. Nearly all of the CTDs display a longterm salinity drift which we do not think is real, but have yet to confirm.

The pilot float array data are being broadcast on the GTS and are published in near-real time on the WWW at: http://www.marine.csiro.au/~waring/cooe/

Both the raw data and plots are available from this site, as well as the ability to explore the data set though an interactive data explorer.

Near future:

Funds have been obtained from both CSIRO and the Bureau of Meteorology for a modest contribution to Argo in the immediate future– funding the purchase and deployment of roughly 20 floats over the next two years. The location of deployment has not yet been finalized but it is likely some will be needed to reseed the pilot array (Indonesian Throughflow). We are pursuing efforts to collaborate with Indonesian colleagues for our future float work.

Potential for expanded participation in Argo:

Both CSIRO and the Bureau of Meteorology are actively pursuing further funding for a larger Australian contribution to Argo.

Appendix 2: Notes for the International Commitments Table

The following details were provided for the International Commitments Table shown in section 2 of this report.

Australia – FY02 starts Jul 1, 02 – 10 floats funded by Commonwealth Scientific and Industrial Research Organization (CSIRO) in FY00 and 10 by Bureau of Meteorology (BoM) in FY01; pending BOM/CSIRO ocean prediction request for 30 floats

Canada – FY starts Apr 1 – funded by Dept. of Fisheries & Oceans with potential funding from Dept. of National Defense, Environment Canada, and others

China – FY starts Jan 1 – funded by Ministry of Science & Technology (National Basic Research Priorities Program, National Climbing Program, and National Special Projects); implemented by State Oceanic Administration in collaboration with other organizations

Denmark – Niels Bohr Institute for Astronomy, Physics and Geophysics is deploying 5 floats in the Greenland Sea and is proposing 30 for next year

European Commission – Gyroscope proposal submitted by France, Germany, Spain, and U.K. has funded 80 floats

France – FY starts Jan 1 – Overall coordination under Coriolis Project; funded and implemented by Institut Francais de Recherche pour l' Exploitation de la Mer, Centre National de la Recherche Scientifique, and Service Hydrographique de la Marine; an additional 8 floats were funded as part of POMME

Germany – FY starts Jan 1 – Argo proposal for 100 floats submitted by AWI/BSH/IfM-Kiel to Ministry for Research & Technology (BMBF) in support of Ministry of Transport (Weather Service [DWD] & Hydrographic Service [BSH])—decision date TBD; other floats include: BSH has funded 18 and 5 floats in FY00 and FY01 for Mid-Atlantic Ridge, Alfred Wegener Institute has funded 10 floats in FY01 for Southern Ocean, Deutsche Forschungs Gemeinschaft (DFG) has funded Institute fuer Meerskunde (IfM) for 7 floats in FY01 for Lab. Sea, proposal submitted by IfM to DFG for 20 floats in Indian Ocean with decision ~Jul 01, and 15 BMBF-funded IfM floats deployed in Tropical Atlantic will be included when data are reported on GTS

India – FY starts Apr 1 – funded by Dept. of Ocean Development; implemented by National Center for Ocean Information Services (lead), National Institute of Ocean Technology, Center for Ocean and Atmospheric Sciences along with National Institute of Oceanography and 6 other academic/R&D/operational institutions

Japan – FY starts Apr 1 – funded by Ministry of Education, Culture, Sports, Science & Technology and Ministry of Land, Infrastructure & Transport; implemented by JAMSTEC, Frontier Research Program, Japanese Meteorological Agency, and Coast Guard; out-year commitment to ramp up to 100+ floats per year

New Zealand – FY02 starts Jul 1, 02 – funded and implemented by National Institute of Water & Atmospheric Research

Republic of Korea – FY starts Jan 1 – funded by Ministry of Science & Technology/Korean Meteorological Administration and Ministry of Marine Affairs & Fisheries; implemented by Korea Argo Subcommittee of the Korea Oceanographic Committee

Russia – Hydromet/Vladivostok has deployed 4 Webb floats in Japan Sea and is proposing to purchase 2 more; data not yet being made available on the GTS

Spain – proposal submitted to Programa Nacional de Investigacion by Instituto Espanol de Oceanografia, Universidad de Las Palmas de GC, and Instituto de Ciencias del Mar de Barcelona-CSIC with decision ~ Oct 01

U.K. – FY starts Apr 1 – funded by Dept. of Environment, Transport & Regions, Ministry of Defense, and Natural Environment Research Council; managed and implemented by U.K. Meteorological Office in collaboration with Southampton Oceanography Center, British Oceanographic Data Center and U.K. Hydrographic Office; out-year commitment to ramp up to 50 Argo floats per year, to be supplemented by up to 40 additional research floats over 3 years depending on successful bids for funding

U.S.A. – FY02 starts Oct 1, 01 – funded by NOAA and Office of Naval Research via National Oceanographic Partnership Program; other contributions are from Naval Oceanographic Office (Navoceano, 16 in FY00, 20 in FY01) and NOAA via Consortium for Ocean Research & Climate (35 in FY00, 20 in FY01); an additional 60 Navoceano floats are dependent on availability of funding; does not include 10 floats funded by NOAA/OAR/Arctic Program Office for deployment in the Bering Sea; 275 floats per year requires funding at a level of $7.2M

Appendix 3: Argo Atlantic deployments

Summary of the discussions held at the International Argo Science Team Meeting in Sidney, BC, Canada, March 21st, 2001.
Present : Desaubies, King, Molinari, Owens, Parrilla, Send, Turton.

There is considerable interest in the Atlantic, particularly in the northern regions ; as one progresses southwards, it will be more difficult to achieve the needed coverage. The aim of the discussions was to coordinate the deployments to avoid redundancy and to fill in gaps. To a large extent that was achieved. What is given here draws attention to possible lack of balance. I suggest that we consider this an iterative process, and that we re-evaluate the strategy in 2002, in the light of the floats active at that time. (There is an apparent over - commitment in the Subpolar gyre: it depends on whether one counts the German floats at 50 or 48°N).

Subpolar Gyre (North of 48°N) : Target 71

1. Norwegian - Greenland Sea :

Greenland sea : D.Quadfasel has just released 5 floats in the Greenland Sea.
Norwegian sea : UK is interested in deploying 5 floats; Turton will check with Norwegian plans, if any.

2. 50 to 65 °N : Target 63

Several German research cruises were identified, which afford opportunities for float deployments in the subpolar gyre during the summer 2001.

Meteor M50/2	02.06.2001 18.06.2001	St. Johns -St. Johns	Labrador Sea	F. Schott
Meteor M50/3	21.06.2001 15.07.2001	St. Johns – Reykjavik	S/E Grönland	Meinke
Meteor M50/4	17.07.2001 12.08.2001	Reykjavik- Hamburg	East Basin	W. Zenk
Poseidon 275	02.06.2001 19.06.2001	Lisbon – Reykjavik	Intergyre to Subpolar	T. Müller

The proposed deployments are summarized in the upper figure below.

US Floats : 6 to be deployed in Labrador Sea during M50/2 – 3. To be coordinated with Schott and Meinke.

German floats : those are not ARGO floats *stricto sensu* , but are research float with data to be made available. This is welcome contribution. Seven in Labrador current will drift down-stream; a number of floats released by Koltermann (BSH) along 50°N are active, more to be deployed in 2001 (it is suggested that those be somewhat spread to increase spatial coverage).

UK floats : 5 active in eastern Irminger ; 5 more to be deployed from M50/3, inside the basin if possible. Additional floats in Icelandic Basin (1), and Rockall trough (2).

EU- GyroScope floats : 10, if possible 15 (depending delivery by WRC) in broad area, as indicated, from Poseidon 275, and M50/4 ; by IFM team (Send and Zenk). An additional 20 in

summer 2002, as needed to fill in gaps and complete coverage, French Ovide cruise, and German research vessels.

Total floats identified : 76

Subtropical Gyre : 20°N to 48° N : Target 155

1. Western : Target 87

The contributions will be mostly from the US (20 floats in 2001, and 20 in 2002), with additional participation from Canada (6 in 2001 and 8 in 2002); France is encouraged to go west of the ridge, with about 10 floats (possibly more) in 2002. Opportunities are on SOOP (AX3, 7, and 8). Contacts with Carke in Canada to coordinate operations in Gulf Stream region (60 to 50°W). **Total floats identified : 64**

2. Eastern : Target 68

The eastern basin of the North Atlantic will be covered by France (5 in 2001, and 30 in 2002), and the EU GyroScope project (40 in 2002). Cruises : Poseidon 275 in 2001, in 2002 one cruise by IEO in April, and by SHOM in March. **Total identified : 75**

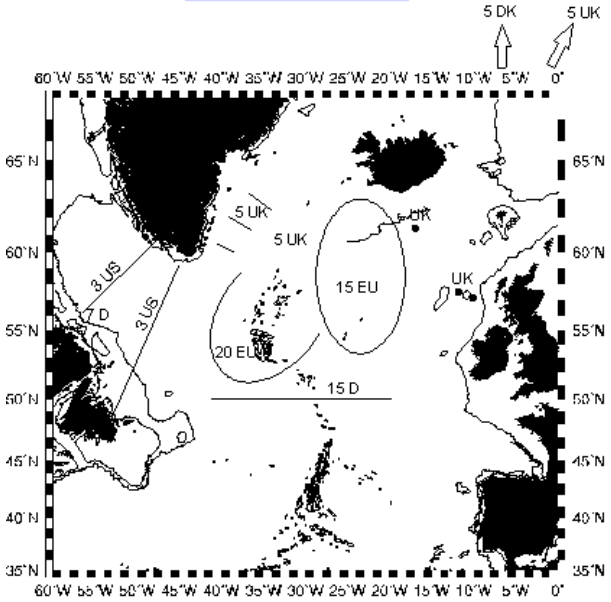
Tropical – Equatorial : 20° S to 20°N : Target 192

France and the US will contribute, with useful German research floats (10) in the western equatorial region. French interest mostly in eastern basin (50 floats at the end of 2002 and beginning of 2003). Suggested cruises are German activities along 17°N, and Meteor 53/2 in May 2002 (Mindelo – Recife, Schott) and M53/3 in June (Recife – Guadelupe, Rhein); PIRATA cruises, and AX8, and AX99(Polarstern to Punta Arenas in Nov. 2001). **Total floats identified : 139**

Southern Subtropical : 40°S to 20°S : Target 133

Deployments in the Atlantic south of 20°S will start in 2002 (10 UK and 20 US floats), with France and the UK anticipating 50 and 10 more, respectively, in 2003. US plans for 2003 were not considered. Thus, **90 floats have been identified** in that later time frame, with possibly more to be decided later. Cruise schedules and opportunities were not discussed.

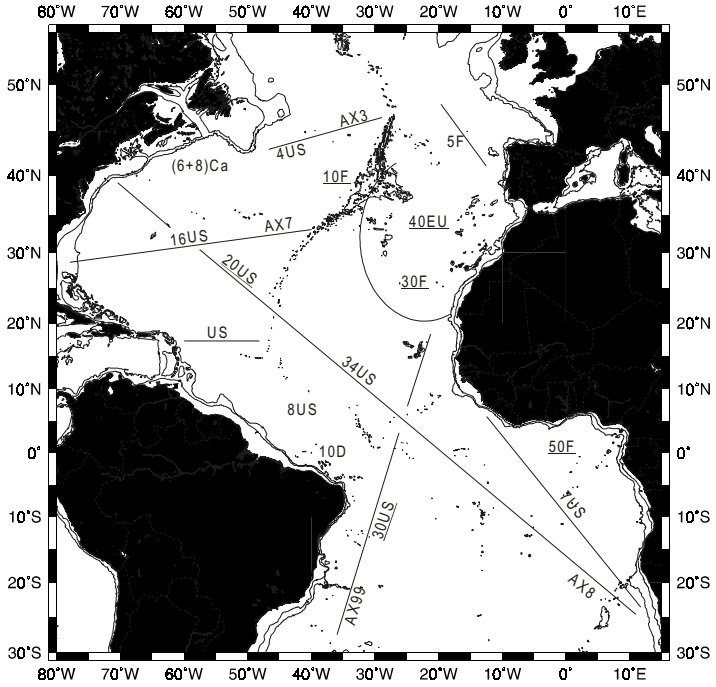
Subpolar Gyre



Legend: ARGO planning for the Subpolar Gyre of the North Atlantic, as of March 2001. All deployments planned for 2001, except the 20 EU around Reykjanes Ridge. US in Labrador Sea (6 fl.) on Meteor 50/2 and 50/3; UK: 5 fl. already in Irminger Sea, 5 more from Meteor 50/3 (June-July), 3 more floats in Icelandic Basin and Rockall trough; EU floats (GyroScope): 15 from Poseidon 275 (June) and Meteor 50/4 (July - August), 20 in 2002 from French Ovide cruise and German cruises, TBD. German floats, marked D in Labrador Sea and along 50°N, are research floats useful for ARGO (some are operating, some to be deployed in 2001).

Underlined numbers in the figure below indicate deployments in 2002.

ARGO déployments in Northern and Tropical Atlantic Ocean, 2001 - 2002



Appendix 4: Argo Information Centre

Background

At its 20th Executive Council, Paris, June 1999, IOC accepted Argo as an important contribution to the operational ocean observing system of GOOS and GCOS, as well as a major contribution to CLIVAR and other scientific research programmes. The Executive Council adopted resolution XX-6 which requires that “the concerned coastal states must be informed in advance, through appropriate channels, of all deployments of profiling floats which might drift into waters under their jurisdiction, indicating the exact location of such deployments.”

A Joint IOC-WMO Circular Letter, JCOMM No. 00-2, was issues in February 2000 to request WMO and IOC Member states to designate National Focal Points for Argo to eventually regularly receive information regarding float deployments by other countries, including float identification number, deployment date, and position. To that end, IOC took steps to establish an international Argo Information Centre staffed by a Co-ordinator. The Centre would basically inform the National Focal Points about planned float deployments, how to track float positions, and how to access float data, in compliance with the IOC Resolution. It was also proposed that the Coordinator would also undertake other tasks for Argo (see annex B). Because of the time needed to establish such a Centre, and to recruit the required staff, an interim mechanism was proposed for informing Member States about float deployments. An Argo Internet forum was set up and used to achieve that goal (http://argo-forum.jcommops.org/, see annex E): whenever a Member State deploys floats, float operator who deployed the instruments shall go on the forum and place relevant information on it. Information therefore becomes public and automatic notification is sent to interested national focal points, whose E-mail addresses have been added in the forum. National Focal Points who have no E-mail address are notified via facsimile.

Establishment of the Argo Information Centre (AIC) and Argo technical coordinator's position

In February 2000, IOC also took steps to find the resources needed to establish the AIC and the Argo Technical Coordinator's position. It was proposed to establish the Centre in Toulouse, France, at CLS and place the Coordinator directly under the supervision of the Technical Coordinator of the DBCP and SOOP who is also located in Toulouse (see annex A). More generally, the Coordinator would receive guidance from the Argo Science Team. AIC and Argo Coordinator would provide the formal mechanism for informing designated contact points in Member States about float deployments, how to track float positions, and how to access float data, in compliance with the IOC Resolution XX-6. The Coordinator would act as a clearing house for information on all aspects of float use, and would promote an improved international dialogue between oceanographers and meteorologists, and between research and operational communities. It was also proposed that the AIC would eventually focus on the following issues:

- advertising the Argo programme, use of float data, and direct participation of Member States in the programme;
- development of co-operative arrangements for float deployment;
- implementation of a global system, including standardisation and Quality Control, for the distribution in real time of float data for assimilation by oceanographic and coupled oceanographic/meteorological models;
- promoting the flow of float data to the designated archives; and

- assisting in solving technical issues between float operators, manufacturers, data telecommunication providers, data assimilation centres, quality control and archiving agencies, etc.

This proposal was presented at the 2nd Argo Science Team meeting, Southampton, March 2000, and at the Pacific Ocean and Indian Ocean Argo implementation meetings in Tokyo and Paris respectively. The Argo Science Team welcomed the proposal and four member states finally agreed to provide required funds on a voluntary basis. Before all the funds could be collected, an interim AIC was established in early 2000, a web site opened (http://argo.jcommops.org/, see annex F), and an interim float deployment mechanism proposed using resources provided by the DBCP and SOOP. An Argo electronic mailing list was also established by the interim AIC (argo@jcommops.org, presently including more than 150 names). A recruitment notice advertised through usual WMO and IOC channels was published in October 2000. The selection committee eventually selected Mr. Mathieu Belbéoch among the candidates and the position could be formally established on 19 February 2001.

Matthieu Belbeoc, 28, married, has a University degree in mathematics & computer science (French DESS), he accumulated one year of practical experience with oceanography and modelling at French LODYC, EPSHOM, and ACRI (e.g. wave model, equatorial Pacific circulation). He is now interested in pursuing a career in Oceanography. The committee believes he has the full potential of becoming a good Argo coordinator and has a practical experience in web development which will be particularly useful for the first year. He speaks English, French , and Spanish.

Present and planned future work of the AIC.

AIC is participating in the activities of the JCOMM in situ Observing Platform Support centre (JCOMMOPS) which will among other things provides integrated information on logistical opportunities available for marine platform deployments (e.g. deployment of floats and drifting buoys, servicing of moored buoys, ships of opportunity, air deployments, etc.).

The Argo Coordinator who operates the AIC and who is acting as a focal point between float operators, data users, etc. will be supporting the international Argo program in a number of ways. These include (i) implementation of IOC resolution XX-6 for notification of deployment of floats which might drift into Member States EEZ, (ii) assistance to reach agreement for deployments within EEZ of Member States, (iii) recovery and refurbishment of floats after their operational life-time, (iv) programme promotion and provision of information on program activities, (v) and assistance with regard to programme implementation. Such assistance with regard to programme implementation is achieved through:

- General international coordination (e.g. web site development and maintenance, coordinator acting as a focal point between float operators and data users, assistance in solving specific technical issues, providing information on how to obtain Argo data)
- Assistance with global and regional implementation of the programme (e.g. coordinating deployment opportunities, providing technical support, including with regard to data telecommunication systems and GTS distribution of the data, attending meetings)
- Participation in the Argo data management team (e.g. GTS aspects such as WMO codes e.g. BUFR, GTS bulletin headers, WMO Identification numbers)
- Integration through JCOMM with other in situ marine observing systems such as those coordinated by the Data Buoy Co-operation Panel (DBCP, instruments such as surface drifting buoys and moored buoys in the high seas, e.g. TAO) and the Ship Of Opportunity

Programme (SOOP, instruments such as XBTs, XCTDs, TSG). This includes working towards facilitating float quality information feedback from users (operating QC procedures) to float deployers, coordinating float deployment opportunities, providing information on requirements (GOOS, GCOS, WWW, CLIVAR, OOPC, GODAE), and providing information on the status of relevant ocean observing systems.

As far as implementation of IOC resolution XX-6, the Argo Coordinator is presently working in defining a new formal mechanism which will include:

- Systematic and formal notification of float deployments to the designated Argo National focal Points. The new mechanism will replace the existing one and should be more simple to use for float operators.
- Development of a web-based information system which will (i) provide information on current float positions relative to EEZs (dynamic maps), (ii) provide technical information on floats (e.g. deployment date and location, last position, parking depth, list of operating sensors) and who operates them (list), and (iii) although Argo data will not be archived at the Argo Information Centre, AIC will provide practical information on how to obtain Argo data through the Argo data centres.

The Argo Science Team is invited to provide additional guidance to the Argo Coordinator for operating the Argo Information Centre.

Appendix 5: List of Attendees
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